TCS Trigger Update

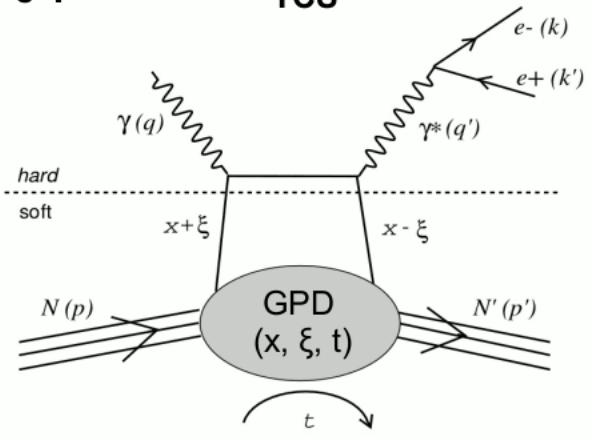
Offline tracking feasability

V. Tadevosyan, with help from B.Wojtsekhowski
05/14/2021

Physics goals

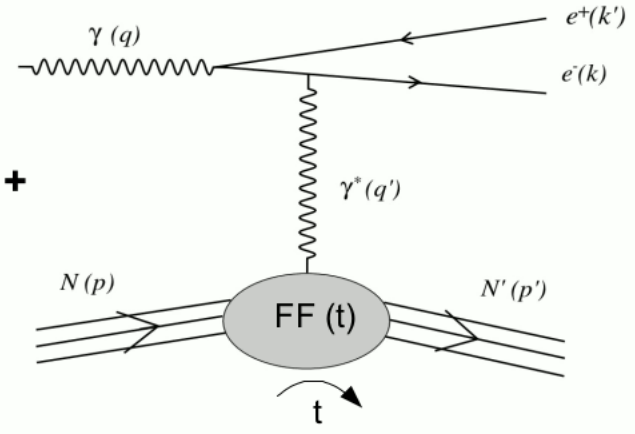
$\gamma P \rightarrow e^+e^- P'$ =

TCS

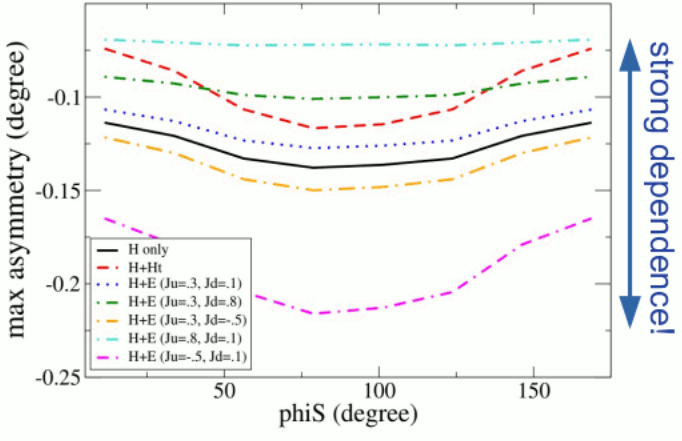


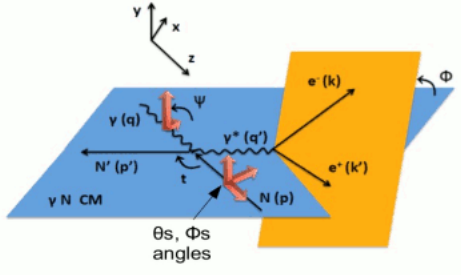
+

Bethe-Heitler



Sin(φ) moment of transverse spin asymmetry vs φ_S,
Dependence in GPD E and $J^{u,d}$ (VGG model)





TSA as a function of φ and φ_S

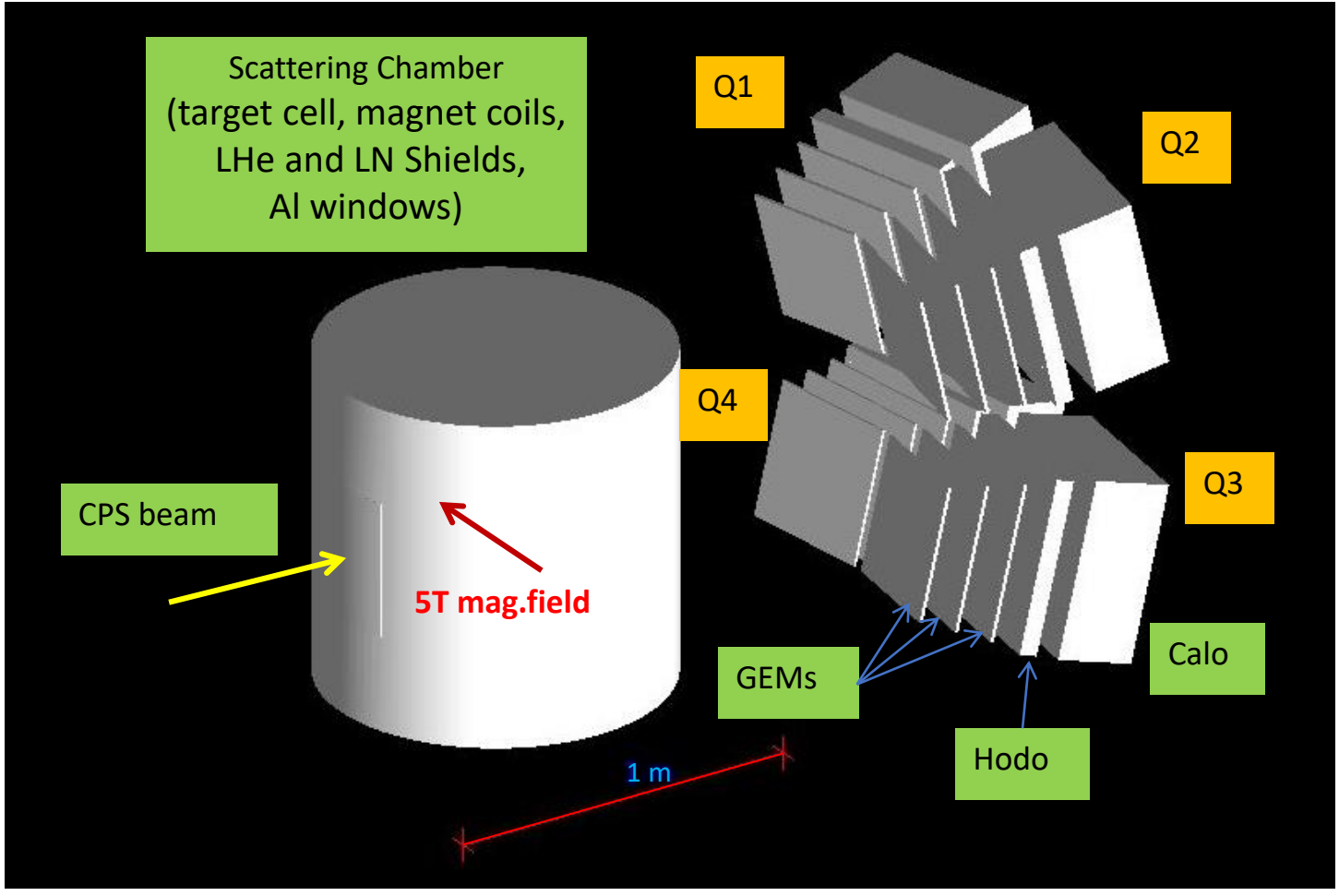
- Sensitive to Im(interference), BH cancels
- Strong dependence in angular momenta,

Sensitivity to GPD E (also to H, Ht)

Courtesy M.Boer

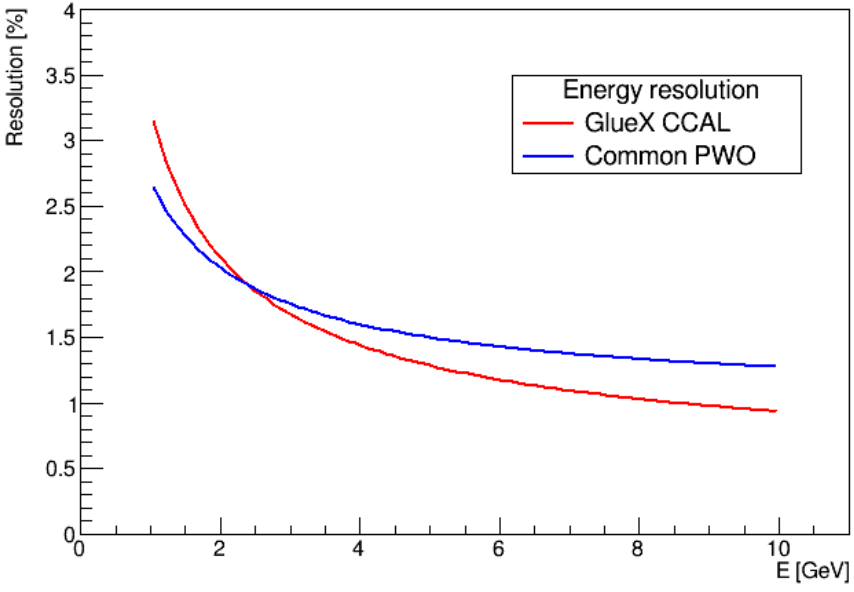
Proposed TCS setup

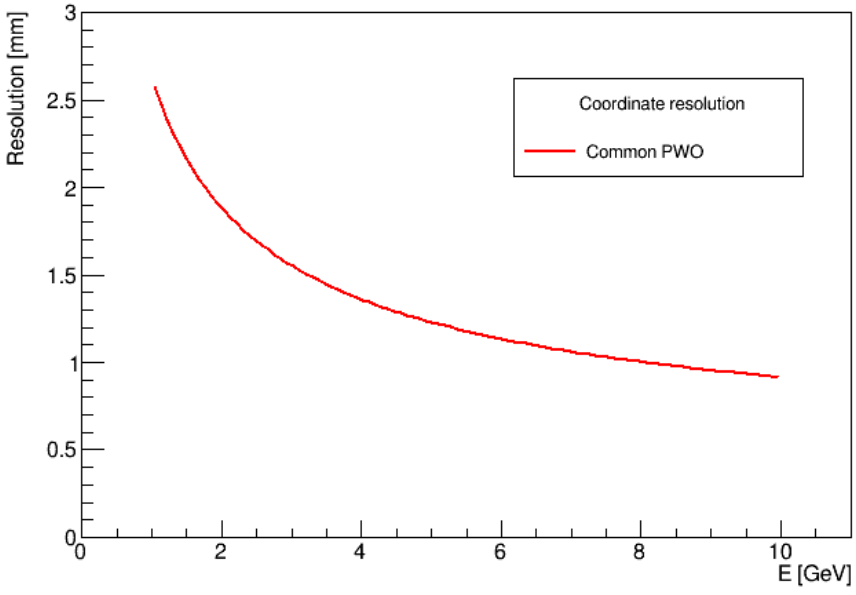
$\gamma + p \rightarrow \gamma^* (e^+ + e^-) + p'$



- Detect e^+, e^-, recoil p' in coincidence
- CPS bremsstrahlung photon beam
- UVA/Jlab NH_3 target, transversely polarized
- Detectors arranged in 4 quarters, oriented to target
- Triple-GEMs for e^+, e^-, p tracking
- Hodoscopes for recoil proton detection/PID
- $PbWO_4$ calorimeters for e^+, e^- detection/PID
- **Trigger based on calorimeter signals**

PWO calorimeter resolutions

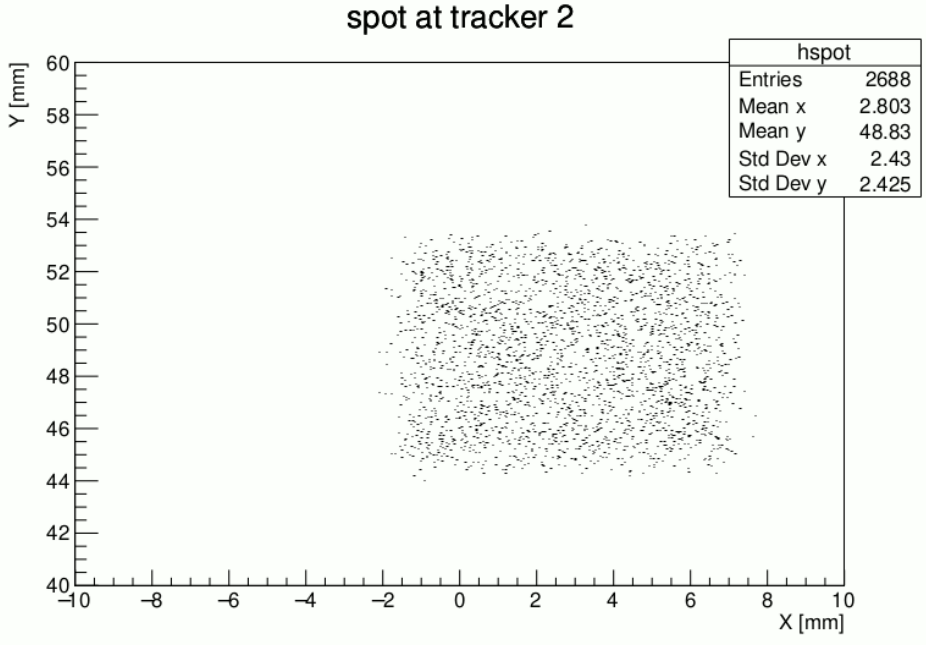


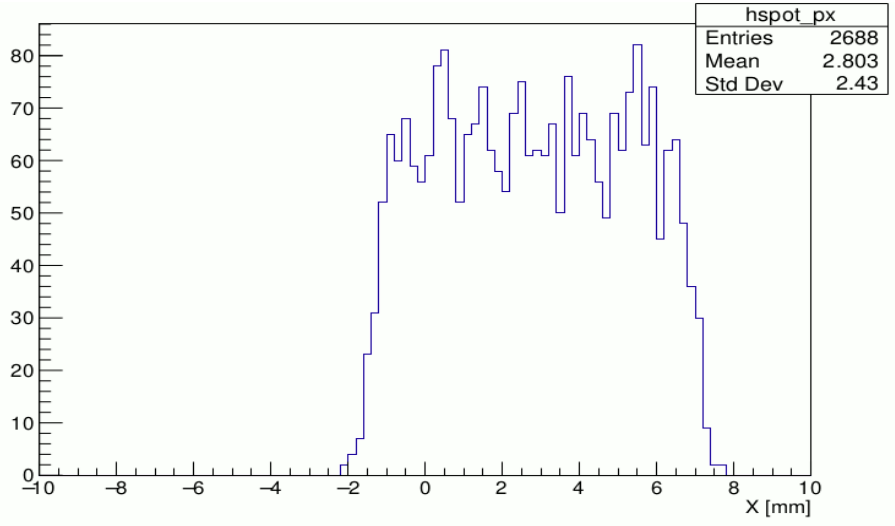


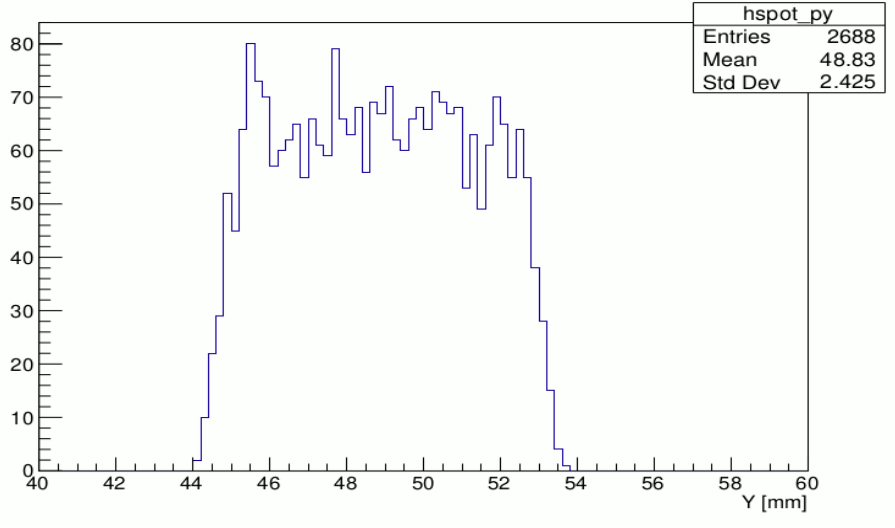
Finite calorimeter resolutions imply a hit spot in the trackers, correspondent to a hit cluster in the calo-s.

- Sample tracks at target within ±3σ(E) energy range, and in solid angle covering 6σ(X)x6σ(Y) spot at calo-s.
- Select tracks within the spot at calo-s.
- Plot XY distribution of hits at trackers.

Tracker 2 hits for 2.5 GeV/c tracks

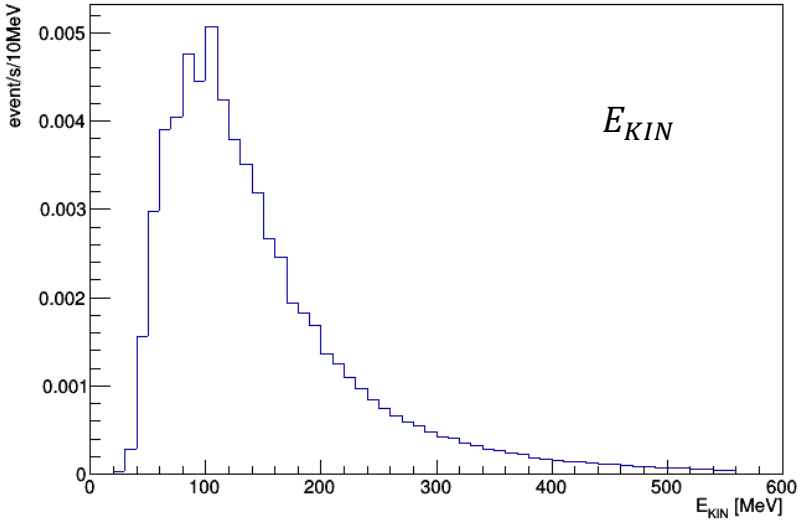


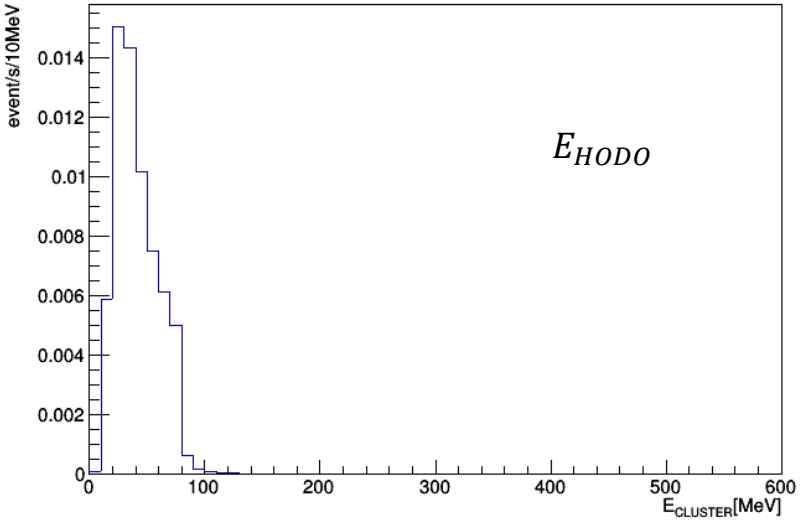


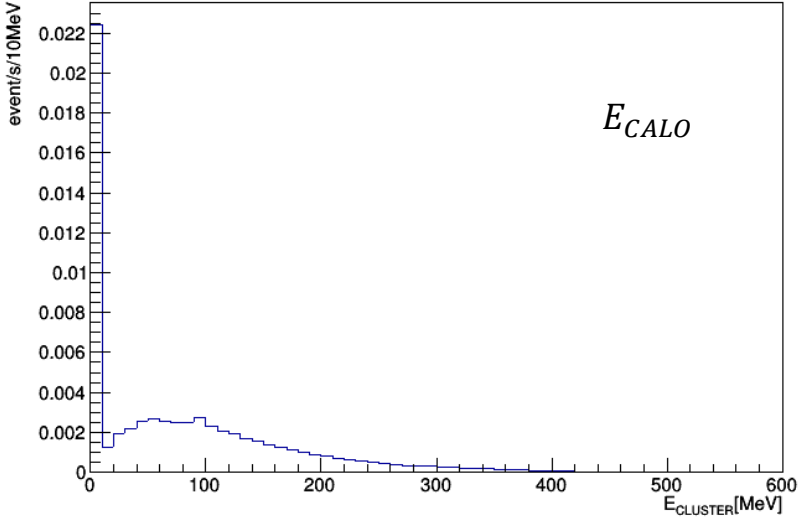


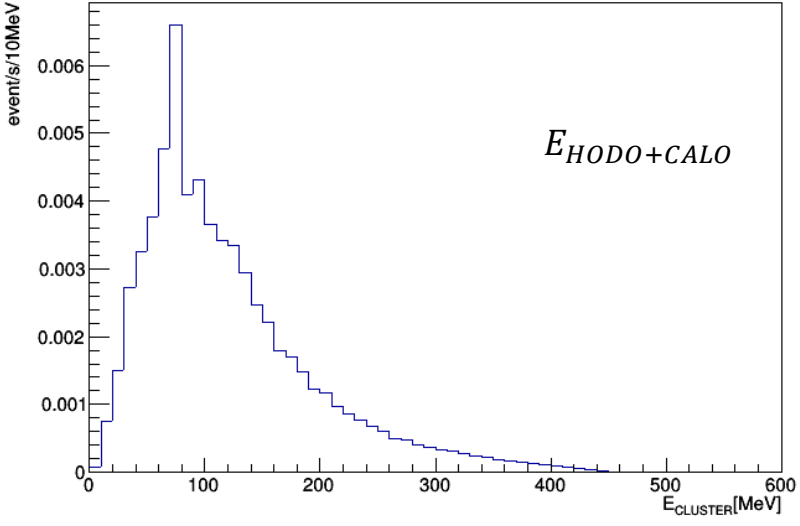
- Area size ~1 cm^2.
- For tracks at center (rate ~1.4 MHz/ cm^2), 50 ns time window: $1.4 \times 10^6 \times 1 \times 50 \times 10^{-9} =$ **0.07 stray track** per TCS $e^{\pm}$ track.
- Bigger by a magnitude close to vertical median plane and beam pipe.

TCS recoil proton in Hodo-s and Calo-s







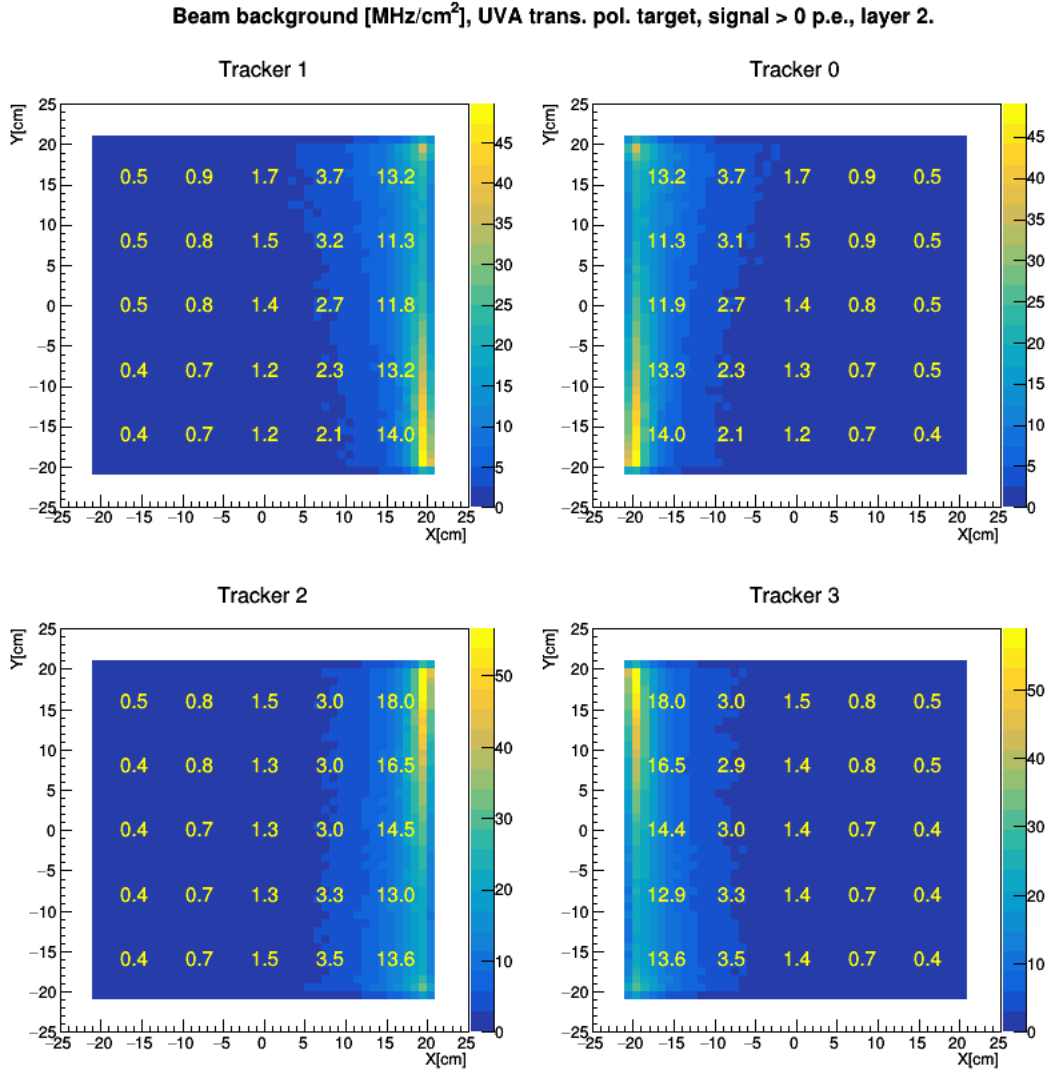


Outlook

- Look for efficiency of vertex reconstruction in presence of accidental coin. Background.
- Estimate background from accidental coincidences in the “exclusivity” plot.

Backup slides

Background at GEM trackers



Beam background particle fluxes at GEM-s:

γ -- 82%
e- -- 11%
e+ -- 6%

Detected in GEM-s (EDEP > 0):

e- -- 65%
e+ -- 33%

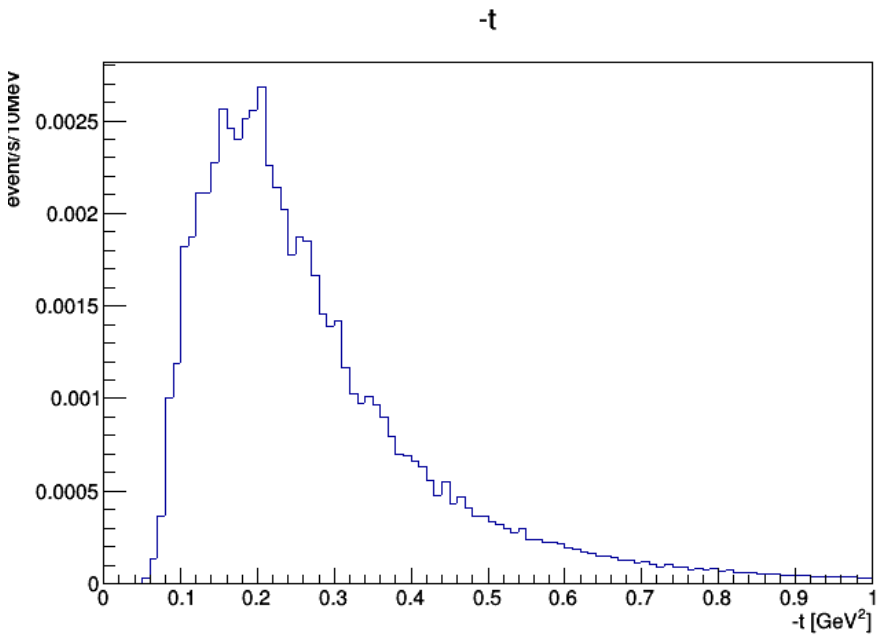
Rate at the middle ~1.4 MHz/cm^2, and tens of MHz close to median plane and beam.

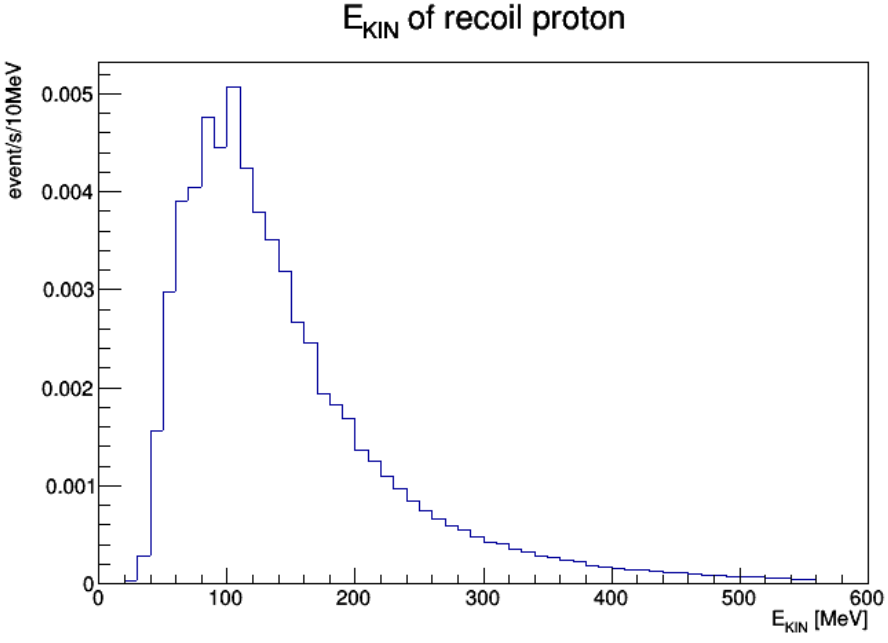
Max. tolerable rates:

COMPASS -- 25 kHz/mm^2
(*PDG'20, chapter 35 Particle Detectors at Accelerators, p.32*)

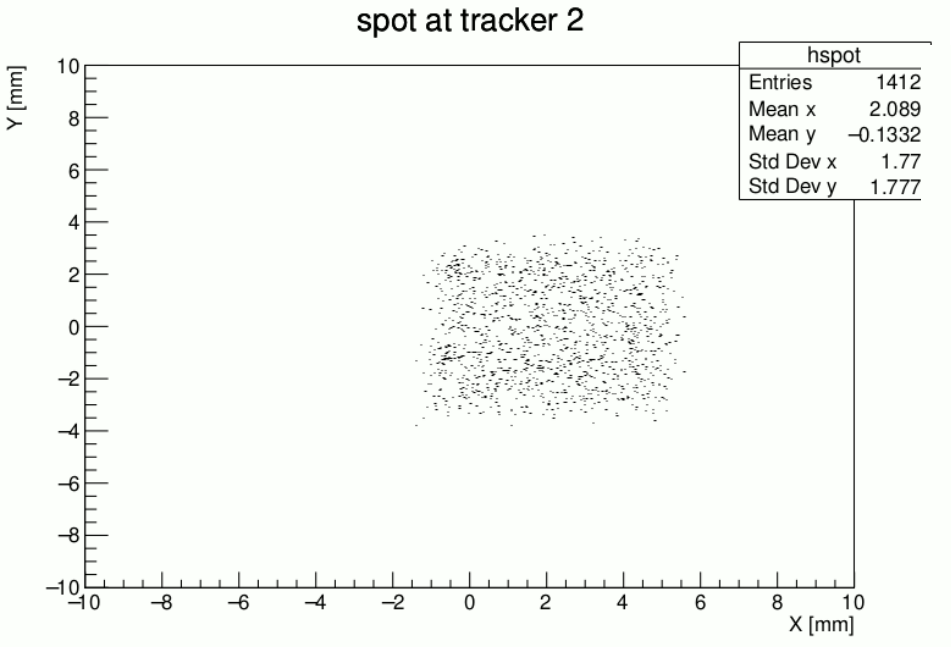
COMPASS after upgrade -- > 10^5 Hz/mm^2
(*M. Krämer, et al., IEEE Nuclear Science Symposium Conference Record (2008)*)

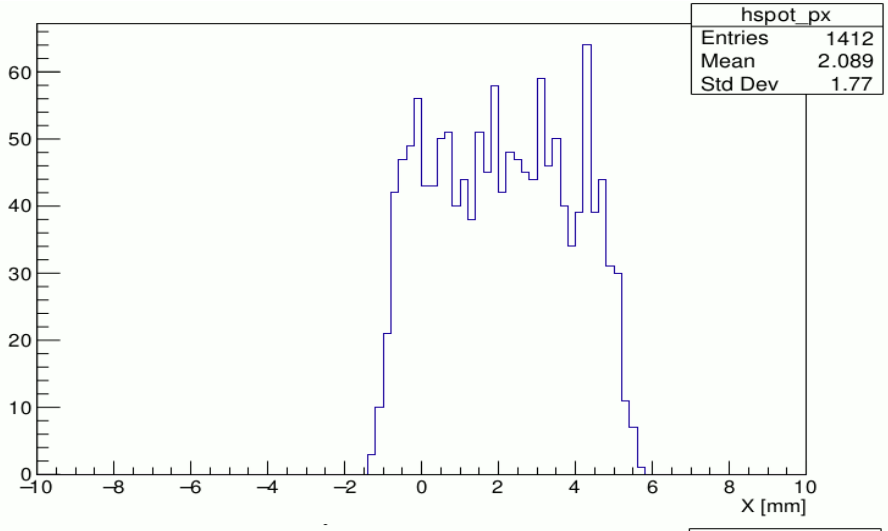
TCS rates manageable for MPGD-s.

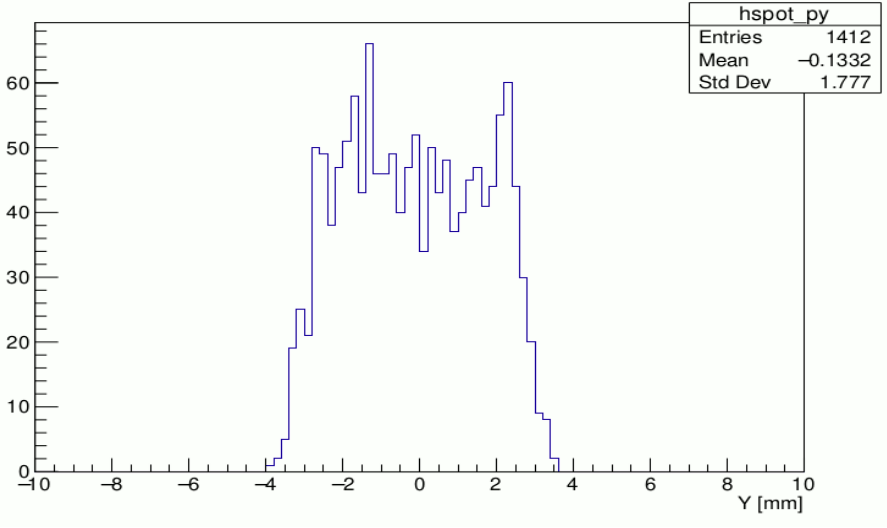

-t
event/s/10MeV
0.0025
0.002
0.0015
0.001
0.0005
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
-t [GeV²]


E_KIN of recoil proton
event/s/10MeV
0.005
0.004
0.003
0.002
0.001
0
0
100
200
300
400
500
600
E_KIN [MeV]

Tracker 2 hits for 5 GeV/c tracks



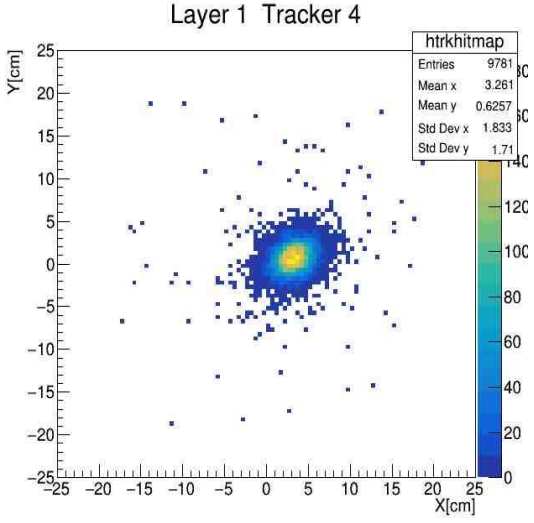




- Area size ~0.6 cm^2.
- For tracks at center (rate ~1.4 MHz/ cm^2), 50 ns time window: $1.4 \times 10^6 \times 0.6 \times 50 \times 10^{-9} = \mathbf{0.04}$ **stray track** per TCS $e^{\pm}$ track.
- Bigger by a magnitude close to vertical median plane and beam pipe.

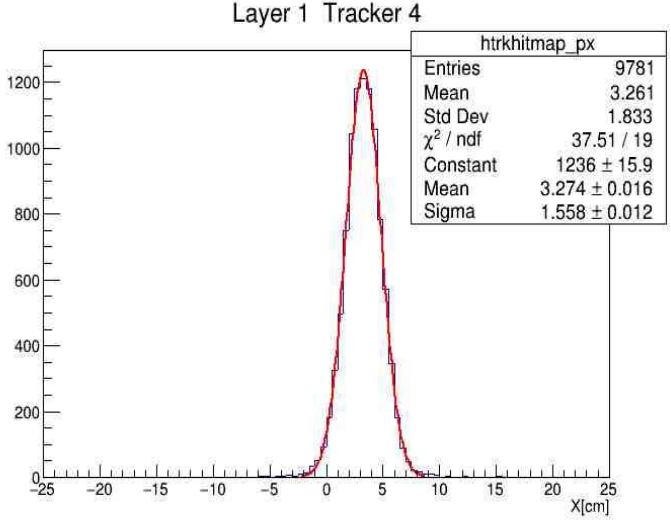
400 GeV/c proton in GEMs (Apr. 20)

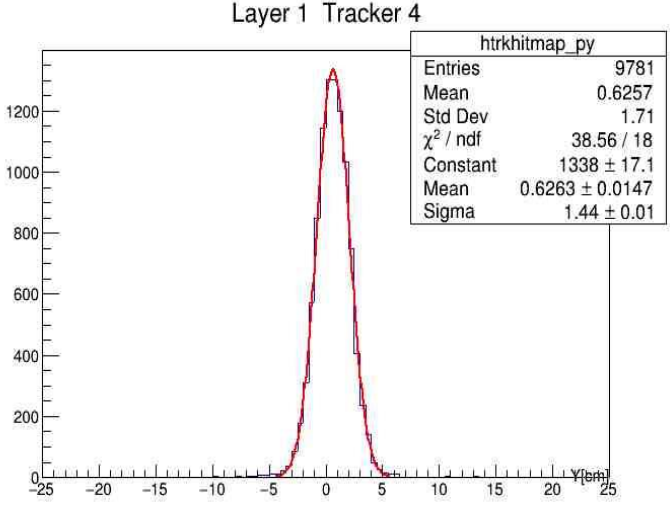
Hit pattern



Tracks with θ_Y = 15° at vertex:

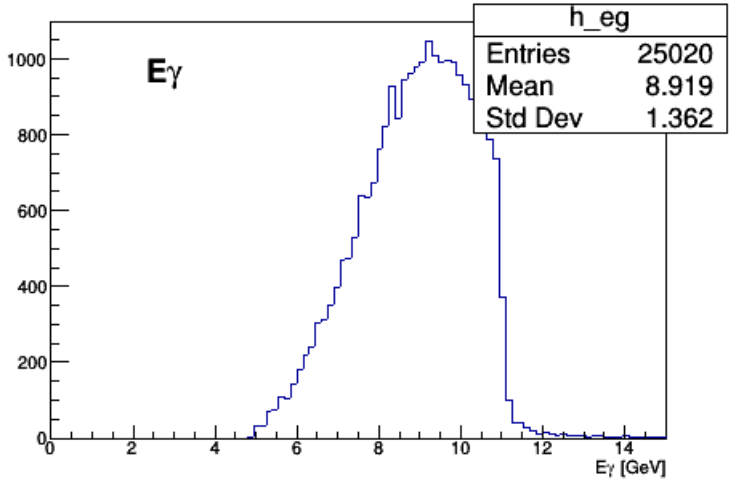
- Hit spot size $\sigma \sim 1.5cm$
- Noticeable fraction of wide scatted tracks
- Fraction of hits within $R < 4.5cm$ -- 94.5%

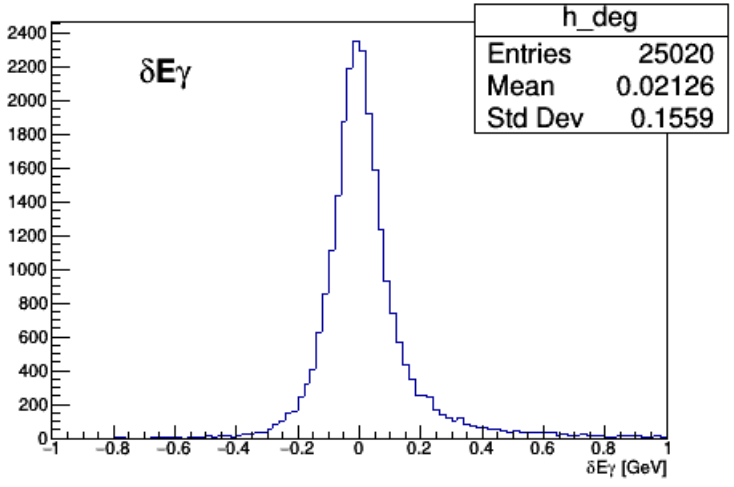


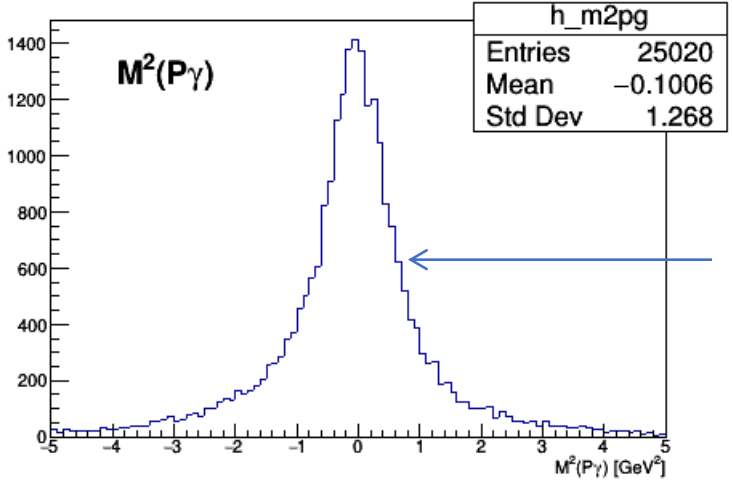


TCS missing mass reconstruction (Feb. 20)

γ incident reconstruction







M_X^2 (exclusivity cuts to be applied)